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Original Paper

Energy content of hybrid *Rumex patientia* L. × *Rumex tianschanicus* A.Los. (Rumex OK 2) samples from autumn months

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Aim of this experiment was to determine the gross energy concentration of fresh, wilted and ensiled hybrid of *Rumex patientia* L. × *Rumex tianschanicus* A.Los. (Rumex OK 2). Samples were collected in autumn months of the year 2017. The plant of Rumex OK 2 consist during autumn months only from rosette of leaves. The height of leaves was in autumn months following, September 56.68 ±13.80 cm; October 59.29 ±11.93 cm and November 55.98 ±10.80 cm. Rumex OK 2 silage was made from wilted matter, with or without of addition of dried molasses. Gross energy was determined as the heat released after combustion of a sample (Leco AC 500) in MJ per kilogram of dry matter of the sample. By the autumn months the concentration of dry matter, as well as the concentration of gross energy increased, except Rumex OK 2 silage from November. The highest concentration of gross energy had wilted Rumex OK 2 from November (18.02 MJ kg^{-1} of dry matter). There was no significant effect of addition of dried molasses to wilted Rumex OK 2 before ensiling on gross energy concentration in Rumex OK 2 silages (P >0.05). Gross energy concentration of all types of analysed samples had relative high value (16.98 to 18.02 MJ kg^{-1} of dry matter). Fresh or ensiled Rumex OK 2 can be used as a part of feed ratio for ruminants or can be utilised in biogas station. However, due to the low content of dry mater in fresh or wilted material the production of silage can be in autumn months problematic.

Keywords: Rumex OK 2, silage, gross energy, dry matter

1 Introduction

Human population growth (1 billion in 1800 to 7.6 billion in 2017) together with rising living standards create growing demand of energy. Nowadays all human activities are connected with consumption of various sources of energy (mainly from fossil energy sources). Therefore the changeover to environmental friendly and a renewable energy sources is expected and appreciate. Maga et al. (2008) defined renewable energy sources as a constantly replenishing source of energy, like a solar or wind energy. Also biomass is a renewable source of energy. Biomass have been used for heat production, as well as for electricity production. Agriculture produce biomass in form of a straw (from cereals, maize or rapeseed), wood waste from fruit grove and vineyards. In Slovak republic, these biomass is insufficiently used for energy purpose (Pepich, 2006). Today is farmed only agricultural soil suitable for intensive crop growing. Soil with low production function, bad localisation or bad climatic condition is not suitable for intensive crop growing. However, this soil can be used for production of biomass. Fodder sorrel, also called "Rumex OK 2" (*Rumex patientia* L. × *Rumex tianschanicus* A.Los.) can be used as a feed as well as for biomass production. Depends on season and on processing, Rumex OK 2 provide different types of biomass: green vegetable biomass, silage and dried vegetable biomass (Rakhmetov and Rakhmetova, 2006; 2011). Dried Rumex OK 2 is produced only in summer months (Usťak, 2007). In this article we aimed to determine the energy value of different Rumex OK 2 samples collected in autumn months of the year 2017.

2 Material and methods

Rumex OK 2 (*Rumex patientia* L. x *Rumex tianschanicus* A. Los.) was used for this experiment. Plants of Rumex OK 2 were grown in experimental fields under Institute of Biodiversity Conservation and Biosafety (SUA in Nitra). Samples of fresh matter were collected in the year 2017, during months September, October and November (always around 20th day of the month). During sampling,

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the height of leaves was recorded. Fresh samples were wilted for three days. Wilting was realized in indoor conditions, by the open windows and without heating. After wilting, Rumex OK 2 plants were cut to the theoretical length of cut 1.5 centimeter and ensiled. First variant (Rumex OK 2 silage) was ensiled without additives. Second variant (Rumex OK 2 silage + molasses) was ensiled with a 1.0% addition of dried molasses to wilted Rumex OK 2 matter. All samples prepared for ensiling were stored in plastic bags without air (hermetic sealed). During fermentation process, which last for five weeks, plastic bags with silage samples were stored in room without light and at 20 °C. Fresh, wilted and silage samples were prepared for dry matter and energy concentration determination. Dry matter was determined by drying at 103 ±2 °C to constant weight. Gross energy concentration was determined by Calorimeter LECO AC 500 (Leco Corporation, USA). Each sample was analysed in triplicate. Gained results were statistically processed with IBM SPSS v. 20.0. Differences of means between months within type of sample were tested by Tukey HSD test. Differences of means between silages samples (with or without an addition of dried molasses) within month were tested by independent samples *T*-test. $P < 0.05$ was considered as significant.

3 Results and discussion

Rumex OK 2 (*Rumex patientia* L. x *Rumex tianschanicus* A.Los.), which is high productive crop with interesting amount of protein has potential to be used in feed industry, as a food, as a medical herb, as well as a technical plant (Usťak, 2007; Rakhmetov and Rakhmetova, 2011; Bazhay-Zhezherun and Rakhmetov, 2014). Growth and production process of plants is affected by many factors (Hric et al., 2013). Rumex OK 2 is plant with sufficient production of biomass also in autumn months. In autumn months whole Rumex OK 2 plant consist only from different number of leaves which create rosette of leaves.

The average height of leaves from Rumex OK 2 used in this experiment was as follows: in September 56.68 ±13.80 cm; in October 59.29 ±11.93 cm; in November 55.98 ±10.80 cm. The utilization of Rumex OK 2 depends mainly of its dry matter concentration and plant morphology. As shown Table 1, fresh Rumex OK 2 samples from autumn months have very low concentration of dry matter, from 4.89 to 7.70%. After three days of wilting, concentration of dry matter increased, however wilted Rumex OK 2 samples were for direct combustion unusable. During September was unfavourable weather, a lot of rainfall and high humidity, and that was the reason of low dry matter value in fresh, as well as in wilted samples. Wilted Rumex OK 2 matter was used for ensiling. Compared to wilted Rumex OK 2 matter, silage samples contain similar amount of dry matter. In general fresh Rumex OK 2 samples contain very low amount of dry matter. Plants like Rumex OK 2 also contain low amount of dry matter. For example dock (*Rumex obtusifolius* L.) contains 11.4% of dry matter (Derrick et al., 1993); spinach (*Spinacia oleracea* L.) contains 8.40% of dry matter, rhubarb (*Rheum undulatum* L.) contains 6.41% of dry matter (Kováčiková et al., 1997). Leaves from sugar beet (*Beta vulgaris* var. *altissima* Döll) and from turnip (*Beta vulgaris* L.) used as a feed contain 16.5% and 17.0% of dry matter respectively (Petrikovič et al., 2000; Pajtáš et al., 2009; Gálik et al., 2016). Petříková (2009 and 2012) published concentration of dry matter in Rumex OK 2 samples collected between 25th of April to 26th of May with values between 8.89 to 13.01%, bud *Rumex* spp. in these months has different morphology, has besides rosette of leaves the stalk with flowers and seeds. Rumex OK 2 silage from September following the dry matter concentration in wilted matter had very low concentration of dry matter. With such a low concentration of dry matter (7.82%) is ensiling of wilted matter in farm condition unviable and with dry matter of wilted matter around 17% is problematically. Low concentration of dry matter of wilted matter causes outflow of silage effluent during fermentation (Skládanka et al., 2014). Hejduk and Doležal (2008) wilted *Rumex obtusifolius* L. for 24 hour and reached dry matter 16.84%, which is similar to our results. Suitability of Rumex OK 2 for ensiling will be considered better after evaluation of data from results of fermentative process. Petrikovič et al. (2000) published

Table 1 Energy value of different Rumex OK 2 samples from autumn months (MJ kg^{-1} of DM)

Month 2017	Fresh Rumex OK 2		Wilted Rumex OK 2		Rumex OK 2 silage		Rumex OK 2 silage + molasses		SEM
	DM	GE	DM	GE	DM	GE	DM	GE	GE
September	4.89^{a}	17.76	7.82^{a}	17.52^{a}	7.04^{a}	17.00^{a}+	7.37^{a}	16.98^{a}+	0.095
October	n.d.	n.d.	16.91^{b}	17.67^{b}	18.23^{b}	17.75$^{b\circ}$	17.23^{b}	17.53$^{b\circ}$	0.050
November	7.70^{b}	17.99	17.01^{c}	18.02^{c}	17.97^{b}	17.65$^{b\square}$	18.45^{c}	17.66$^{b\square}$	0.053

DM – dry matter concentration of sample in %; GE – gross energy concentration of sample in MJ kg^{-1} of dry matter; n. d. – non defined; SEM – value of standard error of the mean for gross energy in that month; ^{abc} – means within a column bearing different superscript differ significantly at $P < 0.05$; +$^{\circ\square}$ difference of mean values of GE between Rumex OK 2 silage and Rumex OK 2 silage + molasses were within month nonsignificant ($P > 0.05$)

concentration of dry matter in ensiled leaves from *Beta vulgaris* var. *altissima* Döll and *Beta vulgaris* L. on value 17.00% for both, which is less, bud comparable with our results from months October (18.23 and 17.23%) and November (17.97 and 18.45%).

Energy value of samples is expressed as the amount of gross energy in 100% of sample dry matter (Table 1). Highest concentration of gross energy contains wilted Rumex OK 2 from November.

The addition of 1% of dried molasses to wilted Rumex OK 2 matter before ensiling did not affect the concentration of gross energy in silages (P >0.05 for all three months). Statistical differences of means between months within type of sample (column) is shown in Table 1. Due to low concentration of dry matter of samples from September, the concentration of gross energy in samples from September was significantly lower, compared to October and November samples. *Spinacia oleracea* L. contains 8.81 MJ kg^{-1} of dry matter, *Rheum undulatum* L. contains 3.74 MJ kg^{-1} of dry matter (Kováčiková et al., 1997), which is much less than by the Rumex OK 2 fresh matter. Gross energy concentration of leaves of *Beta vulgaris* var. *altissima* Döll is 14.75 MJ kg^{-1} of dry matter, and leaves of *Beta vulgaris* L. contains 14.83 MJ kg^{-1} of dry matter. Rumex OK 2 was cultivate for high production of biomass with sufficient amount of crude protein, therefore is concentration of gross energy higher compared to spinach, rhubarb, turnip or sugar beet leaves. By months increase the concentration of gross energy in Rumex OK 2 fresh and wilted matter, similar it is with silage samples, except Rumex OK 2 silage from November (Table 1). Petříková (2011) stated, that dry matter concentration of young *Rumex* spp. plant is for ensiling low. But *Rumex* spp. plant with stalks from spring months can be ensiled together with grass with high dry matter concentration. Such a silage can be used as a feed or for biogas production. *Rumex* spp. from autumn months consist only from rosette of leaves, which mean without stalks with flowers and seeds. In this experiment, only wilted and cut Rumex OK 2 leaves were ensiled, with or without an addition of dried molasses. In the past, connection of words *Rumex* spp. and silage was only in articles describing the effect of broadleaved dock (*Rumex obtusifolius* L.) on grass silage quality (Hejduk and Doležal, 2004 and 2008); abundance of broadleaved dock (*Rumex obtusifolius* L.) in silage (Humphreys et al., 1999); as a part of silage for reindeer (Wallsten, 2003), or the survival of broadleaved dock (*Rumex obtusifolius* L.) in an unmanaged grassland (Martinkova et al., 2009) was researched. These researches were aimed on *Rumex obtusifolius* L., which is considered as one of the most troublesome weeds in intensively managed permanent grassland (Holm et al., 1977). It seems that silage only from Rumex was not neither made nor researched and if, than the information about gross energy concentration is missing. Only possible comparison can be with silage from leaves of *Beta vulgaris* var. *altissima* Döll, or leaves of *Beta vulgaris* L., which contain 14.77 and 15.00 MJ kg^{-1} of dry matter respectively (Petrikovič et al., 2000). These values of gross energy concentration are lower than those of Rumex OK 2 silages (Table 1). Compared to gross energy concentration in maize silages (18.50 to 19.18 MJ kg^{-1} of dry matter) used for bioenergy utilization published by Juráček et al. (2010) the values of gross energy determined for Rumex OK 2 samples were lower. Reason for this is that maize silage was made from maize with corn, whereas Rumex Ok 2 from autumn months used for silage production in this study did not contain seeds. As published Bíro et al. (2007) the nutritive value as well as the energy concentration of maize silage is in positive correlation to amount of corn on a plant.

4 Conclusions

Rumex OK 2 produced during the autumn months attractive amounts of biomass with low concentration of dry matter, bud with relative high concentration of gross energy in kg of dry matter. Biomass produced by Rumex OK 2 during autumn months is in farm condition hardly usable for ensiling (due to low dry matter concentration), however this fresh biomass or silage can be used as a pasture for ruminants or used as a part of feed ratio or can be utilized in biogas station.

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